HARMFUL CYANOBACTERIAL BLOOM ACTION PLAN

FOR PUBLICLY ACCESSIBLE LAKES AND RESERVOIRS OF WYOMING

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SUMMARY

This Action Plan is intended to provide the Wyoming Department of Environmental Quality (WDEQ), Wyoming Department of Health (WDH), Wyoming Livestock Board (WLB), land and water management agencies and other cooperators with procedural guidelines should a harmful cyanobacterial bloom (HCB) be suspected in publicly accessible lakes or reservoirs in the State of Wyoming. Guidelines include: steps for evaluating whether a bloom is likely to contain harmful cyanobacteria; procedures to test for harmful levels of cyanotoxins and cyanobacteria; cyanotoxin and cell density thresholds for issuing a public health advisory; example signage for public notifications; and public outreach materials and protocols. The plan also outlines the notification process should a HCB be identified in a public drinking water supply. Publicly accessible lakes and reservoirs used for recreation are the primary focus of this plan since contact, accidental ingestion and inhalation of cyanotoxins or other cyanobacteria-related irritants are most likely to occur in these waterbodies. This plan will be updated as new information becomes available.

For more information on HCBs in Wyoming, visit WDEQ's webpage at WyoHCBs.org.

Table A. General strategy for HCBs in publicly accessible lakes and reservoirs of Wyoming.

Evaluation	Responsive Action
Step 1: Observation and Reporting	• WDEQ and/or cooperators should visually inspect publicly accessible lakes and reservoirs during recreation season (see Appendix A for photos of Wyoming HCBs). • In the event of a bloom or a suspected HCB, report to WDEQ using the *Report a Spill* hotline at WyoSpills.org or (307) 777-7501. • WDEQ will also use satellite imagery, if available, to monitor lakes and reservoirs for cyanobacterial blooms.
Step 2: Optional Preliminary Screening	• WDEQ or a cooperator can use optional jar and/or stick tests[1] to determine if cyanobacteria are present in a bloom or field test strips[2] to determine if cyanotoxins such as microcystins are present. • If tests are indicative of cyanobacteria or cyanotoxin presence, tests are inconclusive, or the waterbody is known to have had cyanobacterial blooms in the past[3], the land and water management agency may choose to place an **UNDER INVESTIGATION** sign at the water body to inform recreationalists of potential health risks. • If field test strips indicate that cyanotoxins are present in reservoirs with a drinking water intake, cooperators should notify WDEQ. WDEQ will then notify the public water supply and EPA[4].
Step 3: Sample Collection, Analysis and Issuing Advisories	• WDEQ or a cooperator should collect two water samples[5] for laboratory analyses: one sample for cyanobacteria identification and enumeration and one sample for cyanotoxin analysis. Each sample should be collected and shipped according to WDEQ Standard Operating Procedures. • If analyses indicate cyanobacteria densities ≥20,000 cells/mL or total microcystin concentrations ≥10 µg/L, WDEQ will notify WDH and WDH will issue an **ADVISORY**. • When an **ADVISORY** is issued, WDH will inform the water management agency and local health authorities. WDEQ will notify local county coordinators. WDH will coordinate posting of **ADVISORY** signage by the land and water management agency, local health authorities and/or local county coordinators. • If cyanotoxin levels exceed drinking water thresholds in water bodies with the likelihood to impact drinking water supplies, WDEQ will notify the public water supply and EPA[4]. • Due to potential impacts to migratory birds, fisheries and other wildlife, WDEQ will notify USFWS and WGFD when an **ADVISORY** has been issued. • If cyanobacteria are present that produce cyanotoxins other than microcystin, WDEQ will determine if additional samples need to be collected and analyzed for those cyanotoxins. If samples are collected and those cyanotoxins are detected, WDH will determine whether the cyanotoxin concentrations warrant issuance of an **ADVISORY**. • Current and historic advisories can be viewed on WDEQ's website at WyoHCBs.org.
Step 4: Monitoring and Lifting Advisories	• While under an **ADVISORY**, water should be observed approximately weekly by the land and water management agency. • Once the water clears and the bloom has fully dissipated, the land and water management agency should provide visual evidence to WDEQ. WDEQ will determine if the bloom has fully dissipated based on visual evidence and satellite imagery, if available. Once WDEQ determines the bloom has fully dissipated, WDEQ will report results to WDH and WDH will lift the **ADVISORY**. • Once WDH has lifted the **ADVISORY**, signage should be removed by the land and water management agency, local health authorities and/or local county coordinators. • WDH may issue a **CLOSURE** at any time during the process based on the threat to public health.

Abbreviations: EPA, US Environmental Protection Agency; WDEQ, Wyoming Department of Environmental Quality; WDH, Wyoming Department of Health; WGFD, Wyoming Game and Fish Department; WLSB, Wyoming Livestock Board; USFWS, United States Fish and Wildlife Service.

[1] See Appendix D for procedures on the Jar and Stick Tests; adapted from the Kansas Department of Health and Environment: www.kdheks.gov/algae-illness/download/Jar_Test.pdf

[2] Abraxis Fresh Water Strip Test with QuikLyse™ used to detect microcystins in recreational water (10 ppb or µg/L): http://abraxiskits.wpengine.com/wp-content/uploads/2015/08/Microcystins-Strip-for-Recreational-Water-R082115.pdf

[3] See Appendix B for a list of Wyoming lakes and reservoirs with documented cyanobacteria blooms.

[4] EPA implements the Safe Drinking Water Act in the State of Wyoming.

[5] A total of two water samples do not include duplicates; see WDEQ Standard Operating Procedures for collecting duplicates.

Table B. Cyanotoxin and cyanobacteria cell density thresholds for a recreational use.

Threshold	Threshold Values	Responsive Action
Recreation	≥ 10 µg/L total microcystins[1,*] ≥ 20,000 cells/mL cyanobacteria Other cyanotoxins as determined by WDH	ADVISORY
WDH determines there is sufficient threat to public health to restrict use of an impacted area or an entire reservoir.		CLOSURE

Abbreviations: WDH, Wyoming Department of Health; µg/L, micrograms per liter; cells/mL, cells per milliliter.

[1] Microcystin thresholds (µg/L) represent total concentrations of all congeners.

* In May 2019, the US Environmental Protection Agency released Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin; the 8 µg/L total microcystins and 15 µg/L cylindrospermopsin recommendations are being reviewed for potential incorporation.

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DEFINITIONS

Cooperator	An entity or agency working jointly with the Wyoming Department of Environmental Quality, Wyoming Department of Health and Wyoming Livestock Board to achieve Action Plan objectives.
Cyanobacteria:	A phylum of bacteria that obtain their energy from photosynthesis. Cyanobacteria are often referred to as *blue-green algae*, however they are taxonomically distinct from true algae. Cyanobacteria are commonly found in phytoplankton communities, but can also colonize benthic substrates and macrophytes.
Cyanotoxins:	Toxins produced by cyanobacteria. Contact, ingestion and inhalation of these toxins can cause serious health impacts to humans, pets and livestock.
Harmful Cyanobacterial Bloom (HCB)	A highly dense concentration of cyanobacteria where there is an elevated risk to human or animal health due to cyanotoxin production or other cyanobacteria-related effects. Previously referred to as a harmful algal bloom or HAB.
Local County Coordinators:	Local government coordinators responsible for preparing and protecting the public against problems that occur within their county.
Microcystin:	A cyanotoxin that primarily affects the liver. Microcystin is a common toxin (more than 100 congeners) with the most widely available toxicological data. Common cyanobacteria in Wyoming that produce microcystin are *Anabaena*, *Aphanizomenon, Aphanocapsa*, *Microcystis*, and *Pseudanabaena*.
Phytoplankton:	Small photosynthetic organisms suspended in the water column. Phytoplankton communities commonly include cyanobacteria and algae.
Publicly Accessible Lakes or Reservoirs:	Those lakes and reservoirs occurring on public or private land that can be used, entered and reached by the public without the permission of the land owner or land management agency.
Scum:	A cyanobacterial bloom that densely accumulates at the water surface, producing a visible layer or colony.

INTRODUCTION

Purpose

In the event of a suspected harmful cyanobacterial bloom (HCB) in a publicly accessible lake or reservoir in the State of Wyoming, an effective action plan needs to be in place so the public can be notified of potential health risks. This action plan provides: steps for evaluating whether a bloom is likely to contain harmful cyanobacteria; procedures to test the bloom for cyanotoxins and cyanobacteria cell densities; cyanotoxin and cell density thresholds to use for issuing a recreational use advisory; example signage for public notifications; recommendations for how to best inform the public of the health implications associated with HCBs; and procedures to determine when a bloom has dissipated and a recreational use advisory can be lifted. Currently, the scope of this action plan will focus on HCBs in publicly accessible lakes and reservoirs used for contact recreation (i.e., swimming, boating, fishing, and other activities with frequent contact with the water) where contact, accidental ingestion, and inhalation of the water are likely to occur.

Background

HCBs are dense concentrations of cyanobacteria that create an elevated risk of serious health consequences for humans, pets, and livestock through contact, ingestion, and/or inhalation of cyanotoxins or other cyanobacteria-related irritants. Other consequences of HCBs include ecological dead zones (e.g., fish kills), ecotourism losses and negative impacts to drinking water supplies, agriculture and wildlife (Carmichael, 1992; Fawell et al., 1993; WHO, 1999). Cyanobacteria are commonly referred to as blue-green algae since they appear and function similar to algae, however, they are taxonomically distinct from true algae. Accordingly, HCBs were previously referred to as harmful algal blooms or HABs.

Under normal conditions, cyanobacteria are present in the water column at low levels. When blooms occur, cyanobacteria become visibly abundant, typically forming dense colonies on the water surface (i.e., scums) and generally making the water green to bluish-green in appearance. Some toxin-producing blooms (e.g., *Planktothrix rubscens*) may occur deeper in the water column and are not visible at the surface. Other blooms (e.g., *Cylindrospermopsis* spp.) may appear brownish-green like turbid water (USGS, 2008).

Some species of cyanobacteria produce cyanotoxins under certain environmental conditions. Toxins produced by cyanobacteria can affect: the central nervous system, digestive system and renal system through ingestion; the respiratory system through inhalation; and the skin, eyes, nose, mouth and throat through contact. Health effects of toxin exposure may include nausea, fatigue, shortness of breath, coughing, disorientation, rashes, blisters, itching, numbness, burning, headache, fever, abdominal pain, vomiting, diarrhea, pneumonia, inflammation of the liver and impaired kidney function. Effects may occur within minutes to days after exposure. In extreme cases, cyanotoxins may lead to pet or livestock death. Currently, there are no known antidotes for cyanotoxins (Carmichael, 1992; Fawell et al., 1993; WHO, 1999). Health effects may also be linked to cyanobacteria cells and associated irritants, though these sources and their mode of action remain unclear (USEPA 2019.

The type of cyanotoxins present in a water body depends on the species/genera of cyanobacteria, though some species/genera are capable of producing multiple types of toxins. Cyanobacteria blooms in Wyoming's publicly accessible reservoirs are typically comprised of eight genera: *Anabaena* (also known as *Dolichospermum*)*, Aphanizomenon, Aphanocapsa*, *Lyngbya, Microcystis, Nodularia, Planktolyngbya* and

Pseudanabaena. These genera have the potential to produce the toxins aplysiatoxins, lipopolysaccharide, lyngbyatoxin-a, cylindrospermopsin, microcystin, nodularin, anatoxin, beta-N-methylamino-L-alanine, neosaxitoxins and saxitoxin (Table C). These toxins are categorized by their primary mode of action: dermatoxins (i.e., skin irritants), hepatotoxins (i.e., affect liver function), and neurotoxins (i.e., affect central nervous system).

Table C. Common cyanobacteria in Wyoming lakes and reservoirs and their associated cyanotoxins.

Cyanobacteria Genera	Dermatoxins			Hepatotoxins			Neurotoxins			
	APL	LPS	LYN	CYL	MC	NOD	ATX	BMAA	NEO	SAX
*Anabaena**		X		X	X		X	X	X	X
Aphanizomenon		X		X	X		X	X	X	X
Aphanocapsa		X			X					
Lyngbya	X	X	X	X				X		X
Microcystis		X			X		X	X		
Nodularia		X				X		X		
Planktolyngbya		X								
Pseudanabaena		X			X					

Data provided in this table are largely based on results documented in USGS (2008), WHO (1999), EPA website.
Toxin abbreviations are as follows: APL, aplysiatoxins; LPS, lipopolysaccharides; LYN, lyngbyatoxin-a; CYL, cylindrospermopsins; MC, microcystins; NOD, nodularins; ATX, anatoxins; BMAA, β-N-methylamino-L-alanine; NEO, neosaxitoxins; SAX, saxitoxins.
**Anabaena* is also known as *Dolichospermum.*

When released from cyanobacteria, extracellular cyanotoxins are colorless and may remain in the water column after a bloom has dissipated. Studies have shown cyanotoxins persisting anywhere from five days to several months in water and up to six months in dry scum (USEPA 2019). The rate at which cyanotoxins are removed depends on environmental factors such as water pH and temperature, ultraviolet degradation, the presence of particulate matter, water depth and bacterial breakdown (USGS 2008, USEPA 2019). Studies have also shown that certain strains of microcystin can remain in sediments for months or, conversely, bypass sediments and enter groundwater. Cyanotoxins and cyanobacteria can also flow downstream from lakes and reservoirs for indeterminate long distances (USEPA 2019).

Many factors including excess nutrients, sunlight, wind, flow and temperature contribute to the formation of HCBs. Although blooms can occur at any time, they are more likely to occur in late summer and early fall when reservoir temperatures warm, water levels stabilize, nutrients are assimilated, and phytoplankton productivity increases. Blooms may occur in some reservoirs following turn-over when nutrients are released from the bottom of a reservoir as cooler water is brought toward the surface. Shallow reservoirs, those with long residence times, or those with elevated concentrations of nutrients have an increased likelihood of blooms.

Threshold Derivation

A critical objective of this plan is to identify the point at which the public should be informed of health risks associated with recreating in a lake or reservoir with bloom forming cyanobacteria. The plan uses cyanobacteria cell density and ambient concentrations of the cyanotoxin microcystin, as these are currently the most reliable methods of determining potential health risks.

Microcystin is used since this cyanotoxin is the most naturally abundant and has the most available toxicological data. The World Health Organization (WHO 2003) recommends measuring total microcystin

levels (i.e., the sum of intracellular and extracellular microcystin concentrations) in order to account for all potential toxicity. For these reasons, the microcystin thresholds presented in this plan are intended to represent total microcystins.

Since all cyanobacteria do not produce microcystin and there may be risks associated with direct contact to cyanobacteria cells (USEPA 2016), this plan also identifies potentially harmful densities of cyanobacteria. Recent research reiterates the fact that cyanobacteria are highly diverse and capable of producing different toxins at different times, some of which may not be documented (Otten and Paerl 2015). As such, Otten and Paerl (2015) suggest that thresholds be corroborated by cyanobacteria densities to account for other toxins and associated health effects. For these reasons, Wyoming thresholds also include a cell density component, and the collection of samples for cyanobacteria identification and enumeration is recommended.

This plan identifies threshold values for microcystin (≥ 10 µg/L) and cyanobacteria density (≥ 20,000 cells/mL) above which the Wyoming Department of Health (WDH) will issue a recreational use ADVISORY (Table B). CLOSURES do not have an established threshold and may be issued by WDH at any time based on threats to public health.

The recreation threshold was selected after reviewing scientific studies utilized by other state agencies and health organizations as well as the recommendations and collaborative efforts by the U.S. Environmental Protection Agency (EPA), the European Food Safety Authority (EFSA), and/or the WHO (Graham et al., 2009; Farrer et al., 2015; USEPA Policies and Guidelines). The recreation threshold for the State of Wyoming is consistent with WHO (1999) guidelines and represents the level at which acute health effects transition from low to moderate risk (Table D). It is important to note that the 10 µg/L microcystin and 20,000 cells/mL cyanobacteria values are not directly correlated and each component represents a different mode of action: the microcystin concentration represents toxic effects via ingestion while the cyanobacteria density represents cell-associated inflammatory response via contact. These independent derivations are due to the fact that microcystin concentrations vary as a function of the cyanobacteria species present in a bloom and their respective densities (USEPA 2019). The microcystin value used in this plan is an acute threshold that is protective of short-term human exposures. These values may not be appropriate for domestic animals or livestock.

Table D. World Health Organization guidelines for cyanobacterial bloom characterization.

Acute Health Effects	Cyanobacteria (cells/mL)	Microcystin-LR* (µg/L)
Low	< 20,000	< 10
Moderate	20,000 to 100,000	10 to 20
High	100,000 to 10,000,000	20 to 2,000
Very High	> 10,000,000	> 2,000

*Microcystin-LR is commonly used to represent microcystin congeners due to widely available data and known toxicity

In May 2019, the EPA released *Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin* (USEPA 2019). The 8 µg/L total microcystins and 15 µg/L cylindrospermopsin recommendations are being reviewed for potential incorporation into this document.

In circumstances where a cyanobacterial bloom poses a potential health risk due to cyanotoxins other than microcystin, WDH will determine an appropriate threshold if necessary. Thresholds included in this plan will be updated as more cyanobacteria and toxin data are collected in Wyoming's publicly accessible lakes and reservoirs and new scientific information becomes available.

Recreational Use UNDER INVESTIGATION, ADVISORIES and CLOSURES

Prior to laboratory analysis and/or issuing an ADVISORY, land and water management agencies may post an UNDER INVESTIGATION sign to inform recreationalists of potential health risks. This may occur, for example, if preliminary screening is indicative of a HCB, the lake or reservoir has a history of reoccurring HCBs, or the suspected bloom shows signs of worsening. UNDER INVESTIGATION signage may be posted at heavily-used locations around the lake or reservoir.

If the recommended microcystin or cyanobacteria cell density thresholds are exceeded, WDH will issue a recreational use ADVISORY for the lake or reservoir to inform the public there are health risks associated with recreating in the waterbody and they should avoid contact with water and scums in the vicinity of the bloom. Under an ADVISORY, recreationalists are to use their own discretion when using the publicly accessible lake or reservoir, though it is recommended that areas with blooms not be used for recreation that may result in contact or ingestion of cyanobacteria or cyanotoxins.

Following issuance of an ADVISORY, WDH will inform the water management agency. WDH will also notify local health authorities of the situation and provide information on common cyanobacteria and cyanotoxin-related symptoms. If a drinking water intake is located on or downstream of the lake or reservoir, the Wyoming Department of Environmental Quality (WDEQ) will notify public water supplies as well as the U.S. Environmental Protection Agency (EPA) who implements the Safe Drinking Water Act in the State of Wyoming (see Appendix B). WDEQ will also notify local county coordinators so the appropriate action can be taken in their respective county (see Appendix C). Because of potential HCB-related impacts to migratory birds, eagles, fisheries and other wildlife, WDEQ will notify the U.S. Fish and Wildlife Service (USFWS) and the Wyoming Game and Fish Department (WGFD) once an ADVISORY is issued. Notifications will be sent primarily through a government Listserv account.

WDEQ will include the reservoir in a list of current and historic ADVISORIES in table and map format on WDEQ's webpage at WyoHCBs.org.

WDH will coordinate the posting of ADVISORIES by land and water management agencies, local health authorities and/or local county coordinators. ADVISORY signs should be posted at all heavily-used locations around the lake or reservoir so they can be easily seen by recreationalists. Signs need to be posted around the waterbody since blooms may form, reform and move to different areas at any given time. For example, it is common for shifting wind to concentrate blooms in downwind areas.

An ADVISORY will not be lifted until the bloom has fully dissipated. WDEQ will determine if the bloom has fully dissipated based on visual evidence provided by the land and water management agency as well as satellite imagery provided by the Cyanobacteria Assessment Network (CyAN), if available for the reservoir. Once WDEQ determines that the bloom has fully dissipated, WDEQ will notify WDH and WDH will lift the ADVISORY. WDH will coordinate the removal of ADVISORY signs by land and water management agencies, local health authorities and/or local county coordinators.

According to Wyoming Statute (WS) § 35-1-240, WDH may issue a public beach or water body CLOSURE at any step of the process based on the threat to public health. Actual or potential cyanotoxin and

cyanobacteria-related illnesses will be considered as part of this assessment. WDH will determine the location and extent of a CLOSURE by evaluating the threat to public health or where actual or potential cyanotoxin and cyanobacteria-related illnesses have been documented. WDH will follow usual processes and policies in place for mitigating public health threats, which may include notification of local officials, state agencies, the public, the media and healthcare providers.

WDH and WDEQ will notify health and water quality agencies of adjacent states and/or tribes when an ADVISORY or CLOSURE has been issued for a publicly accessible lake or reservoir that occurs both in the State of Wyoming and in the adjacent state and/or tribal territory.

RESPONSE STRATEGY

The response and monitoring strategies are based on the following levels of evaluation: 1) observation and reporting; 2) optional preliminary screening; 3) sample collection, analysis and issuing advisories; and 4) monitoring and lifting advisories (see Table A).

Observation and Reporting

HCBs may appear blue, green, yellow, white and/or brown in color and look like scums, clumps, floating mats, small grass clippings and/or spilled paint (USGS, 2008). These accumulations may be present at the water surface, evenly throughout the water column, or at specific depths within the water column. See Appendix A for photographs of cyanobacterial blooms in Wyoming. A helpful US Geological Survey Field and Laboratory Guide for identifying toxin-producing cyanobacteria is provided at the following link: https://pubs.er.usgs.gov/publication/ofr20151164.

Water bodies with heavy recreational use, particularly those with swimming beaches or those that are frequently used for immersion recreation, should be visually inspected approximately weekly during the recreation season (i.e., May 1 through September 30). Visual inspection should generally occur through observations by land and water management agencies (e.g., Wyoming State Parks, Historic Sites & Trails; National Park Service; Wyoming Game and Fish Department; United States Forest Service; Bureau of Land Management; Bureau of Reclamation; United States Fish and Wildlife Service) as well as WDEQ, municipalities, and other cooperators. Resource constraints may limit the number of lakes and reservoirs that can be inspected by management agencies on a routine basis. As such, observations of potential HCBs will also rely on public reporting by recreational users. Additionally, WDEQ will use CyAN satellite imagery that can remotely detect HCBs based on the unique spectral signature of cyanobacteria. Lakes and reservoirs with available satellite imagery are identified in Appendix B. Overall, management agencies and other cooperators are encouraged to work with WDEQ and WDH to educate staff and recreationalists on cyanobacterial blooms, their potential health risks, and how to report suspected HCBs.

In the event of a bloom or suspected HCB, observers should immediately report to WDEQ using the *Report a Spill* hotline at WyoSpills.org or call 307-777-7501. If reporting online, observers are encouraged to provide contact information and photographs of suspected blooms so WDEQ may contact the individual and conduct a preliminary evaluation. It is recommended that observers avoid contact with blooms until they are deemed safe. If observers believe that they may be experiencing adverse health effects after

contact with a bloom, they should contact a health care provider or the Wyoming Poison Control Center at 1-800-222-1222. General information on HCB health risks can be found at: https://www.cdc.gov/habs/.

A table of some publicly accessible recreational lakes and reservoirs is included in Appendix B. The table contains recreational activities for lakes or reservoirs, the name and contact number of the entity that manages the water body, whether cyanobacterial blooms have been documented in the reservoir, and whether drinking water intakes are located in or downstream of the water body. This appendix serves as an information source should a suspected HCB occur in one of these lakes or reservoirs. The appendix of reservoirs is not comprehensive. WDEQ and water management agencies will likely prioritize some of these reservoirs for observation and monitoring based on historic cyanobacteria densities as well as use. Appendix B will be updated periodically as new information becomes available.

Optional Preliminary Screening

Field tests are optional but may provide preliminary information on the potential health risks of a suspected HCB as well as the type of laboratory analysis that should be conducted. Once reported to WDEQ, suspected HCBs can be evaluated by WDEQ or a cooperator using jar and/or stick tests to determine whether cyanobacteria are present (see Appendix D for jar and stick methods). WDEQ or a cooperator can also use field test strips (e.g., Abraxis Strip Test®) to test for cyanotoxins such as microcystins. Samplers should follow the protocols provided in Appendix D and/or the appropriate test kit.

All tests should be generally conducted in areas where the public comes into contact with the water (i.e., boat ramps, swimming beaches, etc.). If tests indicate that cyanobacteria and/or cyanotoxin are present, the land and water management agency may choose to post an UNDER INVESTIGATION sign to inform recreationalists of potential health risks (see Appendix F for signage). The UNDER INVESTIGATION sign may also be posted prior to screening if the reservoir has a history of reoccurring HCBs or the bloom shows signs of worsening. Land and water management agencies should coordinate posting UNDER INVESTIGATION signage for the lake or reservoir.

Sample Collection, Analysis and Issuing Advisories

If observations or preliminary screening suggest that a bloom may be harmful, WDEQ or a cooperator should collect two samples for laboratory analysis: one sample for cyanobacteria identification and enumeration and one sample for cyanotoxin analysis. Sample collection should follow procedures outlined in *Harmful Cyanobacterial Blooms: Cyanobacteria Collection (Lentic)* and *Harmful Cyanobacterial Blooms: Cyanotoxin Collection (Lentic)*. An Abraxis Quick Reference Guide for the collection of cyanotoxin samples (i.e., which type of sample container and preservative to use) is included in Appendix E. Samplers should follow all health and safety procedures included in these documents.

The cyanobacteria sample will be shipped to WDEQ's contract laboratory for cyanobacteria identification and enumeration. WDEQ will send cyanotoxin samples to the State of Wyoming Water Quality Lab in Cheyenne, Wyoming, for enzyme-linked immunosorbent assay (ELISA). If other entities are interested in having samples analyzed, a list of common laboratories that handle cyanobacteria identification, cell enumeration and/or cyanotoxin testing is included in Appendix G.

If analyses reveal cyanobacteria density to meet or exceed the 20,000 cells/mL threshold or total microcystin levels to meet or exceed the 10 µg/L threshold, WDEQ will notify WDH and WDH will issue an ADVISORY for the lake or reservoir (see Appendix F for signage). If identification of cyanobacteria reveal

that genera are present that produce cyanotoxins other than microcystin, WDEQ will determine if additional samples need to be collected and analyzed for those cyanotoxins. If samples are collected and those cyanotoxins are detected, WDH will determine whether the cyanotoxin concentrations warrant issuance of an ADVISORY.

Under an ADVISORY, WDH will notify the management agency and local health authorities, and WDEQ will notify local county coordinators, public water supplies, EPA, USFWS and WGFD as described previously. WDH will coordinate posting of ADVISORY signage by land and water management agencies, local health authorities and/or local country coordinators at all heavily-used locations around the lake or reservoir. If thresholds are not exceeded, lake or reservoir management should observe bloom progression, perform additional screening tests or report to WDEQ as necessary.

In the Event of Advisories and Closures

Following the issuance of ADVISORIES or CLOSURES, the WDEQ, WDH, land and water management agencies, local county coordinators and cooperators should coordinate to establish: points of contact for each agency; signage modifications and placement at the lake or reservoir; a monitoring strategy; and a plan for disseminating monitoring results. Appendix F includes an example press release with health effects language and use restrictions. Press releases should not be used without approval from each agency's public information officer or communication coordinator.

Monitoring and Lifting Advisories

Under a recreational ADVISORY, the land and water management agency should monitor bloom conditions approximately weekly. Once the water clears and the bloom has fully dissipated, the land and water management agency should provide visual evidence (i.e., photographs via email) to WDEQ. WDEQ will then determine if the bloom has fully dissipated based on the visual evidence as well as CyAN satellite imagery, when available. If both the visual evidence and satellite imagery, when available, indicate that cyanobacteria are not present, WDEQ will notify WDH and WDH will lift the ADVISORY. Once the ADVISORY has been lifted, WDH will coordinate the removal of signs by land and water management agencies, local health authorities and/or local country coordinators. Following bloom dissipation and sign removal, land and water management agencies should continue to observe the waterbody and report new cyanobacterial blooms if they appear.

If additional cyanobacterial and cyanotoxin samples are to be collected to monitor an ongoing HCB, monitoring strategies should consider bloom size and movement both spatially and temporally, whether human illnesses or animal deaths have been reported, and whether the waterbody has a history of cyanobacterial blooms. If multiple samples are collected to monitor cyanobacteria or cyanotoxins over time, it is recommended that each sample be collected a minimum of 24 hours apart.

PUBLIC OUTREACH

In the event of an ADVISORY or CLOSURE, WDEQ, WDH, Wyoming Livestock Board (WLB) and cooperating agencies should coordinate to ensure that information is disseminated via signs, press releases, videos, websites, periodicals and/or other public forums. Regardless of their occurrence, the WDEQ, WDH, WLB and cooperating agencies should attempt to inform the public of the adverse health effects associated with

HCBs and how to identify and report a suspected bloom. A HCB flyer for public dissemination is included in Appendix H.

PUBLIC WATER SUPPLIES

Due to the serious health effects of cyanobacteria and cyanotoxins, public water supply utilities with surface waters or groundwater under the influence of surface water will be notified by WDEQ when cyanobacterial blooms are suspected within or in close proximity to source waters. Specifically, public water supplies will be notified by WDEQ when cyanotoxin levels exceed the drinking water advisory levels (Table E). WDEQ will also notify EPA, who implements the Safe Drinking Water Act in the State of Wyoming. The children and adult advisory levels correspond with EPA's Ten-Day Health Advisories for microcystin and cylindrospermopsin and represent concentrations at which adverse health effects are anticipated (USEPA 2015a, USEPA 2015b).

Once notified, public water supplies and/or EPA should initiate their own sampling to ensure public safety. WDH may issue a Do Not Drink and Do Not Boil order when finished drinking water exceeds cyanotoxin thresholds. A Do Not Boil order is necessary since boiling will not remove cyanotoxins and may actually increase toxin levels by lysing cyanobacteria cells. These orders should not be lifted until sampling results indicate that cyanotoxins have fallen and will remain below the drinking water advisory thresholds.

Table E. Wyoming drinking water thresholds for cyanotoxin concentrations.

Threshold	Threshold Value	Responsive Action
Drinking Water	≥ 0.3 µg/L Microcystin[1] (children and vulnerable populations[2]) ≥ 1.6 µg/L Microcystin[1] (adults)	Do Not Drink / Do Not Boil
	≥ 0.7 µg/L Cylindrospermopsin (children and vulnerable populations[2]) ≥ 3.0 µg/L Cylindrospermopsin (adults)	

[1] Microcystin thresholds (µg/L) are to be applied to total concentrations of all congeners of those toxins.

[2] Vulnerable populations include pregnant women, nursing mothers, those with pre-existing liver conditions, those receiving dialysis treatment, the elderly and other sensitive populations.

APPENDIX A. Photographs of harmful cyanobacterial blooms in Wyoming.

Woodruff Narrows Reservoir, August 2017

Total microcystins (µg/L)	4.49
Cyanobacteria density (cells/mL)	306,219
Dominant cyanobacteria	*Aphanizomenon flos-aquae*

Boysen Reservoir, August 2017

Total microcystins (µg/L)	111.08
Cyanobacteria density (cells/mL)	56,656,560
Dominant cyanobacteria	*Pseudanabaena*

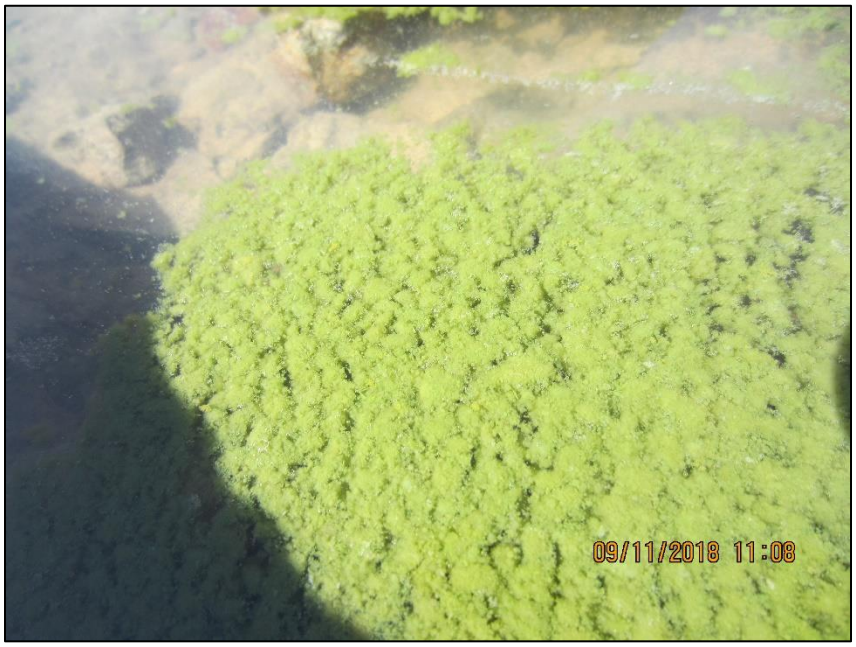
Wheatland Reservoir #3, August 2018

Total microcystins (µg/L)	37.05
Cyanobacteria density (cells/mL)	16,231,501
Dominant cyanobacteria	*Gloeotrichia echinulata*

Lake Viva Naughton, August 2018

Total microcystins (µg/L)	< 0.15
Cyanobacteria density (cells/mL)	23,228,437
Dominant cyanobacteria	*Aphanizomenon flos-aquae*

Big Sandy Reservoir, September 2018



Total microcystins (µg/L)	< 0.15
Cyanobacteria density (cells/mL)	39,935,687
Dominant cyanobacteria	*Dolichospermum lemmermannii*

Flaming Gorge Reservoir, September 2018

Total microcystins (µg/L)	29.61
Cyanobacteria density (cells/mL)	324,915,968
Dominant cyanobacteria	*Dolichospermum*

APPENDIX B1. Publicly accessible lakes and reservoirs and their management, contact information, types of recreation, surface water intakes, bloom occurrence, and satellite imagery.

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
A&M Reservoir	Sweetwater	42.2354, -107.7047	Town of Bairoil	(307) 324-7070	BF	No	No	No	No	-	-
Absarraca Lake	Laramie	41.1611, -104.8384	WGFD	(307) 745-4046	BF	No	No	-	-	-	-
Alcova Reservoir	Natrona	42.5109, -106.7533	Natrona County RBPD	(307) 235-9325	SBF	No	No	Yes	Yes	Yes	Yes
Alsop Lake	Albany	41.3935, -105.7909	WGFD	(307) 745-4046	BF	No	No	Yes	Yes	-	-
Arrowhead Lodge Pond	Sheridan	44.7806, -107.4781	Arrowhead Lodge	(254) 377-3387	F	No	No	-	-	-	-
Bear Lodge Pond	Sheridan	44.7688, -107.5272	Bear Lodge Resort	(307) 752-2444	BF	No	No	-	-	-	-
Beartooth Plateau Lakes	Park	44.9464, -109.5935	Shoshone NF	(307) 527-6921	BF	No	No	-	-	-	-
Beck Lake	Park	44.5115, -109.0433	Beck Lake Park	(307) 587-0400	BF	No	No	Yes	Yes	-	-
Big Sandy Reservoir	Sublette	42.2703, -109.4408	USBR	(801) 379-1000	SBF	No	No	Yes	Yes	Yes	Yes
Billy Creek Reservoir	Johnson	44.1261, -106.7243	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Black Lake	Sublette	42.9308, -109.6535	Bridger-Teton NF	(307) 739-3301	F	No	No	-	-	-	-
Boulder Lake	Sublette	42.8448, -109.6681	BLM	(307) 367-4326	F	No	No	-	-	Yes	Yes
Boysen Reservoir	Fremont	43.2776, -108.1863	1. Boysen SP 2. Northern Arapaho Tribe Nat. Res. Office	1. (307) 876-2796 2. (307) 335-1094	SBF	Boysen Reservoir Intake	No	Yes	Yes	Yes	Yes
Bridger Wilderness Lakes	Fremont	43.2403, -109.6271	Bridger-Teton NF	(307) 739-3301	F	No	No	-	-	-	-
Brooklyn Lake	Albany	41.3720, -106.2503	Medicine Bow-Routt NF	(307) 745-2300	BF	No	No	-	-	-	-
Brooks Lake	Fremont	43.7527, -110.0071	Shoshone NF	(307) 455-2466	BF	No	No	-	-	-	-
Bud Love Ponds	Johnson	44.4376, -106.8570	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Buffalo Bill Reservoir	Park	44.4867, -109.3131	Buffalo Bill SP	(307) 587-9227	SBF	Buffalo Bill Reservoir Intake	Shoshone Municipal	Yes	No	Yes	Yes

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
							Emergency Intake (2 mi)				
Bull Lake	Fremont	43.1865, -109.1229	USBR, Wyoming Area Office	(307) 261-5671	BF	No	No	-	-	Yes	Yes
Bump-Sullivan Reservoir	Goshen	41.8710, -104.2770	WGFD	(307) 777-4600	BF	No	No	Yes	Yes	-	-
Burnt Lake	Sublette	42.8738, -109.6514	Bridger-Teton NF	(307) 739-3301	F	No	No	-	-	-	-
Burlington Lake	Natrona	43.0204, -106.7084	BLM, Casper	(307) 261-7600	BF	No	No	No	No	-	-
Calvin Lake	Sheridan	44.6240, -107.4179	Bighorn NF	(307) 674-2600	F	No	No	-	-	-	-
Christina Lake	Fremont	42.5851, -108.9417	Shoshone NF	(307) 455-2466	F	No	No	-	-	-	-
City Reservoir	Park	44.5084, -109.0491	City of Cody	(307) 527-7511	F	No	No	Yes	No	-	-
Cloud Peak Reservoir	Johnson	44.3934, -107.0978	Bighorn NF	(307) 674-2600	F	No	No	-	-	-	-
Cook Lake	Crook	44.5924, -104.4077	WGFD	(307) 777-4600	BF	No	No	-	-	-	-
Crystal Reservoir	Laramie	41.1564, -105.1999	Curt Gowdy SP	(307) 632-7946	SBF	Crystal Lake Intake	No	No	No	-	-
Deaver Reservoir	Park	44.9017, -108.6341	USBR, Wyoming Area Office	(307) 261-5671	BF	No	No	No	No	-	-
Dollar Lake	Park	44.9182, -109.4912	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Dome Rock Reservoir	Fremont	42.5399, -107.6473	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Duck Pond	Sheridan	44.6084, -107.2951	Bighorn NF	(307) 674-2600	F	No	Big Goose Creek Intake (9.8 mi)	-	-	-	-
Duncan Lake	Sheridan	44.6475, -107.4466	Bighorn NF	(307) 674-2600	F	No	No	-	-	-	-
East Allen Lake	Carbon	41.8768, -106.2202	BLM, WGFD	(307) 745-4046	BF	No	No	Yes	Yes	-	-
East Iron Creek Reservoir	Park	44.6500, -109.0257	Medicine Bow-Routt NF	(307) 745-2300	F	No	No	-	-	-	-
East Newton Lake	Park	44.5446, -109.1180	BLM, WGFD	(307) 527-7125	SBF	No	No	Yes	Yes	-	-
Eden Reservoir	Sweetwater	42.2259, -109.3705	USBR	(801) 379-1000	BF	No	No	Yes	Yes	Yes	Yes

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Elk Mountain Reservoir	Carbon	41.7167, -106.4502	WGFD	(307) 777-4600	F	No	No	Yes	Yes	-	-
Feather Lake	Teton	44.5440, -110.8356	NPS	(307) 344-7381	F	No	No	-	-	-	-
Festo Lake	Platte	42.0773, -104.9996	WGFD	(307) 777-4600	F	No	No	Yes	Yes	-	-
Fiddlers Lake	Fremont	42.6314, -108.8802	Shoshone NF	(307) 455-2466	BF	No	No	-	-	-	-
Fish Lake	Fremont	43.5591, -109.9775	Bridger-Teton NF	(307) 739-3301	F	No	No	-	-	-	-
Flaming Gorge Reservoir	Sweetwater	41.2050, -109.5339	USFS	(435) 789-1181	SBF	Flaming Gorge Reservoir Intake	No	Yes	Yes	Yes	Yes
Fontenelle Reservoir	Lincoln	42.0306, -110.0689	USBR	(307) 261-5628	SBF	No	Exxon Mobil Green River-Shute Creek Gas Plant (4.8 mi)	No	No	Yes	Yes
Fremont Lake	Sublette	42.9537, -109.7920	Bridger-Teton NF	(307) 739-3301	SBF	Fremont Lake Intakes	No	-	-	Yes	Yes
Frye Lake	Fremont	42.7075, -108.8789	WGFD	(307) 777-4600	BF	No	Pogo Agie River Intake (8.5 mi)	-	-	-	-
Gelatt Lake	Albany	41.2379, -105.8367	WGFD	(307) 777-4600	BF	No	No	No	No	-	-
Gillette Lake	Campbell	44.3013, -105.4942	City of Gillette	(307) 686-5200	SF	No	No	-	-	-	-
Glendo Reservoir	Platte	42.5705, -105.0534	WYSPHS	(307) 735-4433	SBF	No	No	No	No	Yes	Yes
Goshen Hole Reservoir	Goshen	41.8891, -104.2823	WGFD	(307) 777-4600	F	No	No	Yes	No	-	-
Graham Reservoir #1	Uinta	41.0695, -110.3917	WGFD	(307) 777-4600	F	No	No	No	No	-	-
Granite Springs Reservoir	Laramie	41.1752, -105.2242	Curt Gowdy SP	(307) 632-7946	SBF	Granite Springs Reservoir Storage	No	No	No	-	-
Grassy Lake	Teton	44.1292, -110.8150	Caribou-Targhee NF	(208) 624-3151	F	No	No	-	-	-	-
Gray Reef Reservoir	Natrona	42.5625, -106.7070	Natrona County RBPD	(307) 235-9325	BF	No	No	-	-	-	-
Green River Lake	Lincoln	42.1926, -110.1618	Bridger-Teton NF	(307) 739-3301	BF	No	No	-	-	-	-

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Greyrocks Reservoir	Platte	42.1673, -104.6980	WGFD	(307) 745-4046	SBF	No	No	No	No	Yes	Yes
Guernsey Reservoir	Platte	42.2874, -104.7659	WYSPHS	(307) 836-2334	SBF	No	No	No	No	Yes	Yes
Half Moon Lake	Sublette	42.9303, -109.7478	Bridger-Teton NF	(307) 739-3301	SBF	Half Moon Lake Intake	No	-	-	Yes	Yes
Hanging Lake	Albany	41.3455, -106.1782	Medicine Bow-Routt NF	(307) 745-2300	F	No	No	-	-	-	-
Hanna Water Supply	Carbon	41.6720, -106.5931	Town of Hanna	(307) 325-9424	F	Rattlesnake Creek Intake (Reservoir)	No	-	-	-	-
Harrington Reservoir	Big Horn	44.3415, -108.2956	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Hattie, Lake	Albany	41.2314, -105.9635	WGFD	(307) 745-4046	BF	No	No	-	-	Yes	Yes
Hawk Springs Reservoir	Goshen	41.6916, -104.1929	WYSPHS	(307) 836-2334	SBF	No	No	Yes	Yes	Yes	Yes
Healy Reservoir	Johnson	44.4166, -106.6039	WGFD	(307) 777-4600	BF	No	No	-	-	-	-
Heart Lake	Park	44.9826, -109.5385	NPS	(307) 344-7381	F	No	No	-	-	Yes	Yes
High Savery Reservoir	Carbon	41.2810, -107.2770	-	-	BF	No	No	-	-	-	-
Hog Park Reservoir	Carbon	41.0386, -106.8961	Medicine Bow-Routt NF	(307) 745-2300	SBF	No	No	-	-	-	-
Hogan Reservoir	Park	44.7864, -109.2582	BLM, Cody	(307) 578-5900	F	No	No	No	No	-	-
Horseshoe Reservoir	Big Horn	44.8795, -108.2594	WGFD	(307) 548-7004	F	No	No	Yes	Yes	-	-
Jackson Lake	Teton	43.8567, -110.5900	NPS	(307) 739-3301	SBF	No	No	-	-	Yes	Yes
Jade Lakes	Fremont	43.7733, -110.0241	Shoshone NF	(307) 455-2466	SBF	No	No	-	-	-	-
Jenny Lake	Teton	43.7646, -110.7322	Grand Teton NP	(307) 739-3301	BF	No	No	-	-	Yes	Yes
Jim Bridger Pond	Sweetwater	41.7294, -108.7816	WGFD	(307) 777-4600	BF	No	No	No	No	-	-
Johnson Creek Reservoir	Albany	41.7814, -105.3739	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Kearny Reservoir	Johnson	44.4457, -107.1339	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Kemmerer City Reservoir	Lincoln	41.9395, -110.6522	City of Kemmerer	(307) 828-3250	BF	No	No	Yes	Yes	-	-

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Keyhole Reservoir	Crook	44.3688, -104.7877	WYSPHS	(307) 756-3596	SBF	No	No	Yes	No	-	-
Kinnear Lake	Fremont	43.1431, -108.6721	Town of Kinnear	(307) 856-2154	BF	No	No	Yes	Yes	-	-
Kleenburn Ponds	Sheridan	44.9056, -107.0127	Sheridan County	(307) 672-7421	F	No	No	No	No	-	-
Kortes Reservoir	Carbon	42.1679, -106.8889	USBR, Wyoming Area Office	(307) 261-5671	-	No	No	-	-	-	-
LAK Reservoir	Weston	43.8278, -104.1094	WGFD	(307) 777-4600	BF	No	No	-	-	-	-
Lake Cameahwait	Fremont	43.3015, -108.2406	WGFD	(307) 332-2688	SBF	No	Boysen Reservoir Intake (1.2 mi)	No	No	-	-
Lake De Smet	Johnson	44.4668, -106.7541	Johnson County	(307) 684-1899	SBF	No	No	No	No	Yes	Yes
Lake Owen	Albany	41.1488, -106.1016	Medicine Bow-Routt NF	(307) 745-2300	BF	Lake Owen Storage	City of Laramie (8 mi)	No	No	-	-
Lake Viva Naughton	Lincoln	41.9693, -110.6592	WGFD	(307) 875-3223	BF	No	No	Yes	Yes	Yes	Yes
Leazenby Lake	Albany	41.1777, -105.5861	WGFD	(307) 777-4600	F	No	No	No	No	-	-
Leidy Lake	Teton	43.7186, -110.3755	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Leigh Lake	Teton	43.8134, -110.7276	Grand Teton NP	(307) 739-3301	SB	No	No	-	-	Yes	Yes
Lewis Lake	Teton	44.3018, -110.6285	NPS	(307) 344-7381	BF	No	No	-	-	Yes	Yes
Little Bear Lake	Park	44.9412, -109.5249	Shoshone NF	(307) 527-6241	F	No	No	-	-	-	-
Little Soda Lake	Sublette	42.9779, -109.8101	WGFD	(307) 777-4600	BF	No	Fremont Lake Intakes (0.5 mi)	-	-	-	-
Little Thunder Reservoir	Campbell	43.6875, -105.3783	Medicine Bow-Routt NF	(307) 745-2300	F	No	No	-	-	-	-
Louis Lake	Fremont	42.5957, -108.8479	Shoshone NF	(307) 527-6241	BF	No	No	-	-	-	-
Lower New Fork Lake	Sublette	43.0889, -109.9641	Bridger-Teton NF	(307) 739-3301	SBF	No	No	-	-	-	-

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Lower North Crow Reservoir	Laramie	41.2209, -105.1903	WGFD	(307) 777-4600	BF	North Crow Diversion Reservoir	No	-	-	-	-
Luce Lake	Park	44.7821, -109.2540	BLM, Cody	(307) 578-5900	F	No	No	No	No	-	-
Luckey Pond	Fremont	42.8441, -108.6949	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Mavrakis Pond	Sheridan	44.8106, -106.9645	City of Sheridan	(307) 672-7421	F	No	No	-	-	-	-
McFarlane Reservoir	Albany	42.2398, -105.6304	Medicine Bow-Routt NF	(307) 745-2300	F	No	No	-	-	-	-
Meadow Lake	Sublette	42.8894, -109.6868	Bridger-Teton NF	(307) 739-3301	F	No	No	-	-	-	-
Meadowlark Lake	Washakie	44.1700, -107.2213	Bighorn NF	(307) 674-2600	BF	No	No	-	-	-	-
Medicine Lake	Crook	44.4372, -104.3150	Bighorn NF	(307) 674-2600	F	No	No	-	-	-	-
Meeboer Lake	Albany	41.2150, -105.8200	WGFD	(307) 777-4523	BF	No	No	Yes	Yes	-	-
Meeks Cabin Reservoir	Uinta	41.0206, -110.5844	USBR	(801) 379-1101	BF	No	No	-	-	-	-
Middle Fork Pond	Johnson	44.3000, -106.9642	Bighorn NF	(307) 674-2600	F	No	No	-	-	-	-
Middle Piney Lake	Sublette	42.6011, -110.5671	Bridger-Teton NF	(307) 739-3301	BF	No	No	-	-	-	-
Miller Lake	Albany	41.0685, -106.1561	Medicine Bow-Routt NF	(307) 745-2300	F	No	No	-	-	-	-
Mortenson Lake	Albany	41.2113, -105.8418	USFWS, Mortensen Wildlife Refuge	(970) 723-8202	-	No	No	Yes	No	-	-
Muddy Guard Reservoirs	Johnson	44.1842, -106.7589	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Murphy Lake	Lincoln	43.0528, -110.8634	Bridger-Teton NF	(307) 739-3301	BF	No	No	-	-	-	-
MW Reservoir	Weston	43.6149, -104.1190	WGFD	(307) 777-4600	F	No	No	-	-	-	-
New Fork Lake	Sublette	43.0948, -109.9469	Bridger-Teton NF	(307) 739-3301	SBF	No	No	-	-	Yes	Yes
North Fork Lake	Sublette	42.9254, -109.5044	Bridger-Teton NF	(307) 739-3301	F	No	No	-	-	-	-
Ocean Lake	Fremont	43.1805, -108.6000	WGFD	(307) 332-2688	SBF	No	No	Yes	Yes	Yes	Yes

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Packers Lake	Goshen	41.8995, -104.0626	WGFD	(307) 777-4600	BF	No	No	-	-	-	-
Palisades Reservoir	Lincoln	43.1689, -111.0343	Caribou-Targhee NF	(208) 557-5900	SBF	-	-	-	-	Yes	Yes
Panther Ponds	Campbell	43.7486, -105.5060	City of Wright	(307) 464-0004	F	No	No	-	-	-	-
Park Reservoir	Sheridan	44.5611, -107.2168	Sheridan County	(307) 672-7421	BF	No	No	-	-	-	-
Pathfinder Reservoir	Natrona	42.4964, -106.9131	Natrona County RBPD	(307) 235-9325	SBF	No	No	Yes	Yes	Yes	Yes
Pelham Lake	Fremont	43.6909, -110.0007	Shoshone NF	(307) 455-2466	F	No	No	-	-	-	-
Phelps Lake	Teton	43.6449, -110.7948	Grand Teton NP	(307) 739-3301	SB	No	No	-	-	-	-
Pilot Butte Reservoir	Fremont	43.2133, -108.7874	USBR, Wyoming Area Office	(307) 261-5671	SBF	No	No	No	No	Yes	Yes
Pines Lodge Pond	Johnson	44.2552, -106.9512	Pines Lodge	(307) 684-9291	F	No	No	-	-	-	-
Ranchester City Pond	Sheridan	44.9013, -107.1771	Town of Ranchester	(307) 655-2283	F	No	No	-	-	-	-
Rawlins Peaking Reservoir	Carbon	41.7438, -107.2582	Town of Rawlins	(307) 328-4500	F	Rawlins Water Supply	No	-	-	-	-
Rawlins Reservoir	Carbon	41.4181, -107.2846	Town of Rawlins	(307) 328-4500	F	Rawlins Water Supply	No	-	-	-	-
Ray Lake	Fremont	42.9541, -108.8310	Wind River Indian Reservation	(307) 332-7810	F	No	No	-	-	Yes	Yes
Renner Reservoir	Big Horn	44.1752, -107.5053	WGFD	(307) 777-4600	BF	No	No	Yes	No	-	-
Ring Lake	Fremont	43.4547, -109.5420	Ring Lake Ranch	(307) 455-2663	BF	No	No	-	-	-	-
Rob Roy Reservoir	Albany	41.1983, -106.2628	Medicine Bow-Routt NF	(307) 745-2300	SBF	Rob Roy Reservoir Storage	No	No	No	-	-
Rock Lake	Platte	41.9862, -105.0270	WGFD	(307) 777-4600	F	No	No	No	No	-	-
Saratoga Lake	Carbon	41.4728, -106.7885	WGFD	(307) 326-5583	SBF	No	No	Yes	Yes	-	-
Sawmill Reservoir and Lakes	Sheridan	44.6249, -107.3032	WGFD	(307) 777-4600	F	No	Big Goose Creek Intakes (8.5 mi)	Yes	No	-	-

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Scotty Lake	Sweetwater	42.2445, -108.4259	BLM, Rawlins Field Office	(307) 328-4224	-	No	No	No	No	-	-
Seminoe Reservoir	Carbon	42.0032, -106.8490	WYSPHS	(307) 328-0115	SBF	No	No	Yes	Yes	Yes	Yes
Sheridan Fairgrounds Pond	Sheridan	44.8047, -106.9861	Sheridan County	(307) 674-2934	F	No	No	-	-	-	-
Shirley Basin Reservoir	Carbon	42.2404, -106.3689	BLM, Rawlins Field Office	(307) 328-4224	BF	No	No	Yes	No	-	-
Shoshone Lake	Fremont	42.7814, -109.0233	Shoshone NF	(307) 527-6241	F	No	No	-	-	Yes	Yes
Shoshone Lake	Teton	44.3683, -110.7189	NPS	(307) 344-7381	BF	No	No	-	-		
Sibley Lake	Sheridan	44.7616, -107.4368	Bighorn NF	(307) 674-2600	BF	No	No	-	-	-	-
Sixtyseven Reservoir	Sublette	42.5977, -110.2208	BLM, Pinedale Field Office	(307) 367-5300	F	No	No	-	-	-	-
Sleeping Indian Pond	Teton	43.5367, -110.7333	USFWS, Jackson National Fish Hatchery	(307) 733-2510	F	No	No	-	-	-	-
Slide Lake, Lower	Teton	43.6345, -110.5271	Bridger-Teton NF	(307) 739-3301	BF	No	No	-	-	-	-
Sloans Lake	Laramie	41.1570, -104.8279	City of Cheyenne	(307) 637-6429	SBF	No	No	Yes	Yes	-	-
Snowy Ridge Lakes	Albany	41.3806, -106.2921	Medicine Bow-Routt NF	(307) 745-2300	F	No	No	-	-	-	-
Soda Lake	Albany	41.2141, -105.8067	WGFD	(307) 777-4600	-	No	No	Yes	No	-	-
Sodergreen Lake	Albany	41.1597, -105.9306	WGFD	(307) 777-4600	BF	No	No	-	-	-	-
South Crow Creek Reservoir	Laramie	41.1278, -105.1929	Curt Gowdy SP	(307) 632-7946	F	South Crow Reservoir Storage	No	-	-	-	-
South Fork Inn Pond	Johnson	44.2775, -106.9515	Bighorn NF	(307) 674-2600	F	No	No	-	-	-	-
Stevens Draw Reservoir	Sweetwater	41.7336, -109.6578	BLM, Rock Springs	(307) 352-0256	F	No	Green River Intake	-	-	-	-
String Lake	Teton	43.7852, -110.7327	Grand Teton NP	(307) 739-3301	SB	No	No	-	-	-	-
Sulphur Creek Reservoir	Uinta	41.1554, -110.8312	City of Evanston	(307) 783-6300	BF	Sulphur Creek Reservoir Intake	No	No	No	-	-

Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Sundance Fairgrounds Pond	Crook	44.4066, -104.3676	City of Sundance	(307) 283-3451	F	No	No	-	-	-	-
Sunshine Reservoir	Park	44.0520, -109.0659	WGFD	(307) 777-4600	BF	Lower Sunshine Reservoir Intake	No	-	-	-	-
Swamp Lake	Park	44.8385, -109.6049	Yellowstone NP	(307) 344-7381	F	No	No	-	-	-	-
Teton Reservoir	Carbon	41.6043, -107.2584	BLM, Rawlins Field Office	(307) 328-4200	BF	No	No	Yes	No	-	-
Tie Hack Reservoir	Johnson	44.2828, -106.9256	Bighorn NF	(307) 674-2600	BF	No	No	No	No	-	-
Toltec Reservoir	Albany	42.2099, -105.7150	NRCS, Laramie Field Office	(307) 745-3698	BF	No	No	-	-	-	-
Torrey Lake	Fremont	43.4637, -109.5530	WGFD	(307) 777-4600	BF	No	No	-	-	-	-
Turner Creek Reservoir	Weston	44.1147, -104.4340	WGFD	(307) 777-4600	F	No	No	-	-	-	-
Turpin Reservoir	Carbon	41.4380, -106.3850	Medicine Bow-Routt NF	(307) 745-2300	BF	No	No	-	-	-	-
Two Ocean Lake	Teton	43.9063, -110.5145	Grand Teton NP	(307) 739-3301	SB	No	No	-	-	-	-
Twin Butte Reservoir	Albany	41.2383, -105.8661	BLM, WGFD	(307) 352-0256	SBF	No	No	Yes	Yes	-	-
Upper New Fork Lake	Sublette	43.1004, -109.9377	Bridger-Teton NF	(307) 739-3301	SBF	No	No	-	-	-	-
Upper North Crow Reservoir	Albany	41.2376, -105.2849	Curt Gowdy SP	(307) 632-7946	BF	North Crow Creek Reservoir Storage	No	-	-	-	-
Upper Sunshine Reservoir	Park	44.0431, -109.0676	WGFD	(307) 777-4600	BF	No	Lower Sunshine Reservoir Intake (3.3 mi)	No	No	Yes	Yes
Walker Jenkins Lake	Carbon	42.3180, -106.1571	WGFD	(307) 777-4600	BF	No	No	-	-	-	-
Wardell Reservoir	Big Horn	44.3506, -108.3080	BLM, WGFD	(307) 527-7125	BF	No	No	Yes	No	-	-
West Newton Lakes	Park	44.5436, -109.1242	BLM, WGFD	(307) 527-7125	SBF	No	No	-	-	-	-
Wheatland Reservoir #1	Platte	42.0013, -105.0377	WGFD	(307) 745-4046	BF	No	No	Yes	Yes	-	-

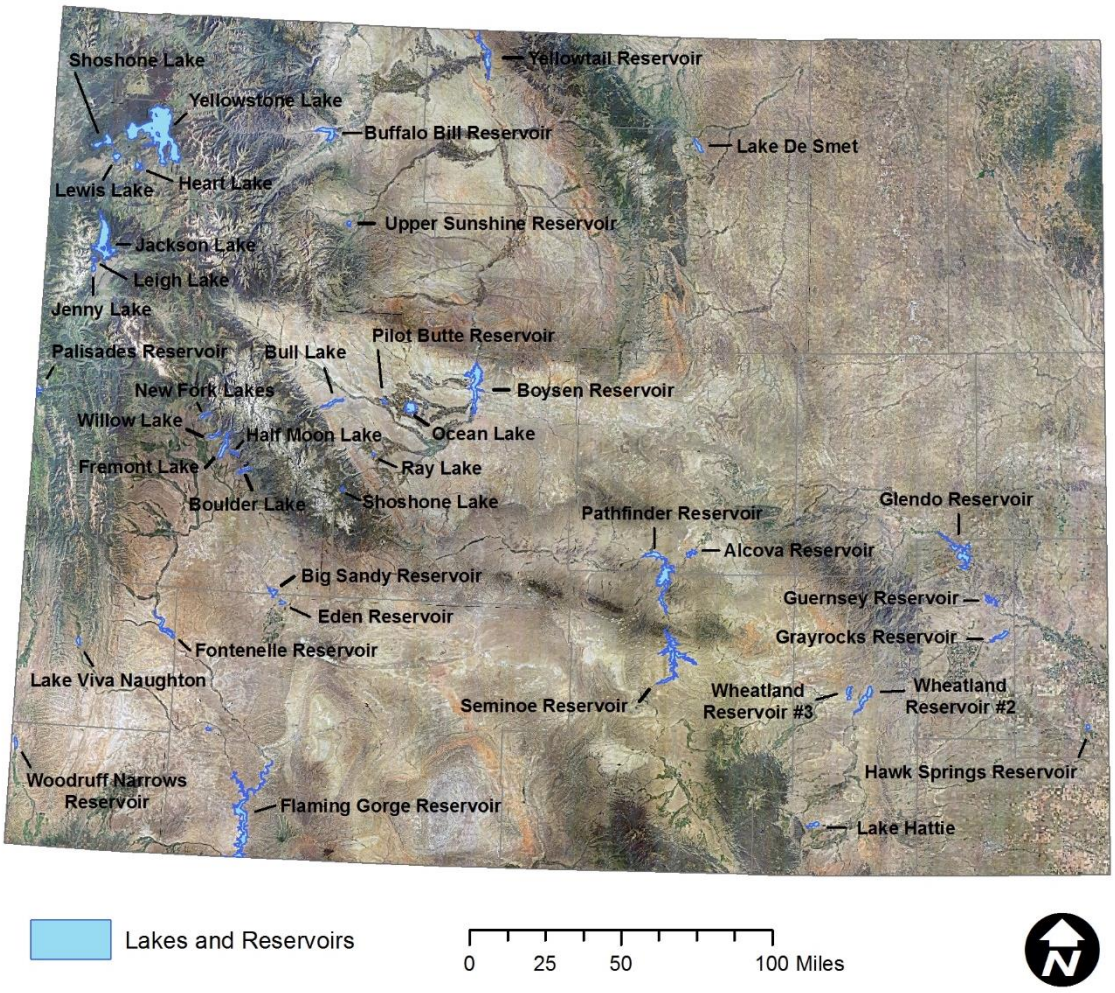
Name	County	Latitude Longitude	Management	Contact	Recreation	Drinking Water Intake (DWI)	DWI 10 mi Downstream	[1]Cyano Sample >20,000 cells/mL	[1]Cyano Sample >100,000 cells/mL	[2]Satellite Imagery >20,000 cells/mL	[2]Satellite Imagery >100,000 cells/mL
Wheatland Reservoir #3	Albany	41.8937, -105.7157	WGFD	(307) 745-4046	SBF	No	No	Yes	Yes	Yes	Yes
Willow Lake	Sublette	43.0026, -109.8651	WGFD	(307) 777-4600	F	No	No	-	-	Yes	Yes
Willow Park Reservoir	Johnson	44.4582, -107.0404	Bighorn NF	(307) 674-2600	F	No	Rock Creek Intake (8.5 mi)	-	-	-	-
Wind River Mtn. Alpine Lakes	Fremont and Sublette	43.2060, -109.5400	Shoshone NF	(307) 527-6241	F	No	No	-	-	-	-
Woodruff Narrows Reservoir	Uinta	41.5021, -111.0184	WGFD	(307) 875-3223	SBF	No	Chevron Carter Creek Gas Plant	Yes	Yes	Yes	Yes
Woods, Lake of the	Teton	44.1067, -110.8415	Caribou-Targhee NF	(208) 523-3278	BF	No	No	-	-	-	-
Worthen Meadows Reservoir	Fremont	42.7006, -108.9251	Shoshone NF	(307) 332-5460	BF	No	Pogo Agie River Intake (9.5 mi)	-	-	-	-
Yellowstone Lake	Teton	44.4652, -110.3610	NPS	(307) 344-7381	BF	Yellowstone Lake Intake	No	-	-	Yes	Yes
Yellowtail Reservoir	Big Horn	44.9536, -108.2840	NPS	(406) 666-2412	SBF	No	No	No	No	Yes	Yes

Recreation abbreviations: B, boating; F, fishing; S, swimming.

[1]"Yes" are for those reservoirs where greater than 20,000 or 100,000 cells/mL of cyanobacteria have been collected 2013-2018. Most collections occurred during routine WDEQ phytoplankton sampling where samples are collected in the deepest portion of a lake or in riverine transitional zones. Sampling that targeted suspected blooms were collected in the densest portion of the bloom where there is also the greatest potential for human exposure; only these samples may include information on cyanotoxin concentrations. "No" are for those reservoirs where sampling revealed cyanobacteria were present but in densities less than listed thresholds. Lakes with a "-" indicate no cyanobacteria were detected or information is not available.

[2]"Yes" are for those reservoirs where greater than 20,000 or 100,000 cells/mL of cyanobacteria have been detected by the Medium Resolution Imaging Spectrometer (MERIS) sensor on the Evisat-1 satellite (2002-2012) or Ocean and Land Colour Instrument (OLCI) sensor on the Sentinel-3a and -3b satellites (2017-present). "No" are for those reservoirs where satellite imagery revealed cyanobacteria were present but in densities less than listed thresholds. Lakes with a "-" indicate no cyanobacteria were detected or imagery is not available. Values represent maximum cyanobacteria densities occurring within a 1 to 2 week composite. Composites are based on a temporal resolution of 1 to 6 days. Spatial resolution of both sensors is 300 m, resulting in 39 resolvable lakes and reservoirs in Wyoming.

APPENDIX B2. Map of Wyoming recreational lakes and reservoirs with cyanobacteria density estimates provided via satellite imagery.



APPENDIX C. List of Wyoming Local County Coordinators

County	Coordinator	Phone	Email	Address
Albany	Aimee Binning	(307) 721-1815	abinning@co.albany.wy.us	501 E. Ivinson Ave Laramie, WY 82070
Big Horn	LaRae Dobbs	(307) 548-2516	bhcemc@gmail.com	355 E. 5th St Lovell, WY 82431
Campbell	David King	(307) 686-7477	dak41@ccgov.net	500 S. Gillette Ave, Suite 1100 Gillette, WY 82717
Carbon	John Zeiger	(307) 326-5715	ccema@carbonwy.com	415 West Pine St, PO Box 6 Rawlins, WY 82301
Converse	Russel Dalgarn	(307) 358-6880	russ.dalgarn@conversecountywy.gov	107 N. 5th St, Suite B8 Douglas, WY 82633
Crook	William Cunningham	(307) 283-2390	williamc@crookcounty.wy.gov	309 Cleveland St, PO Box 475 Sundance, WY 82729
Fremont	Kathi Metzler	(307) 856-2374	fcema@wyoming.com	322 North 8th West Riverton, WY 82501
Goshen	Shelly Kirchhefer	(307) 532-7039	skirchhefer@goshensheriff.org	PO Box 160 Torrington, WY 82240
Hot Springs	William Gordon	(307) 864-4649	bgordon@hscounty.com	415 Arapahoe St, Court House 1st Floor Thermopolis, WY 82443
Johnson	Marilyn Connolly	(307) 684-2761	emc@johnsoncowy.us	76 North Main Buffalo, WY 82834
Laramie	Jeanine West	(307) 633-4333	jwest@laramiecounty.com	3962 Archer Parkway Cheyenne, WY 82009
Lincoln	Jay Hokanson	(307) 877-2126	jhokanson@lcwy.org	421 Jefferson St Kemmerer, WY 83101
Natrona	Stacia Hill	(307) 235-9289	shill@natronacounty-wy.gov	201 N. David, 2nd Floor Casper, WY 82601
Niobrara	Jame Santisteven	(307) 340-0893	niobraracountyema@gmail.com	PO Box 682, 714 S. Pine St Lusk, WY 82225
Park	Martin Knapp	(307) 527-1860	mknapp@parkcounty.us	1131 11th St Cody, WY 82414
Platte	Terry Stevenson	(307) 322-1356; (307) 322-2331	tstevenson@plattecountywyoming.org	PO Box 966, 800 9th St Wheatland, WY 82201
Sheridan	Bruce Edwards	(307) 675-2569	bedwards@sheridancounty.com	224 S. Main, Suite B-1 Sheridan, WY 82801
Sublette	Jim Mitchell	(307) 367-2284	jmitchell@subso.com	PO Box 701 Pinedale, WY 82941
Sweetwater	Judy Roderick	(307) 922-5370	roderickj@sweet.wy.us	731 C Street, Suite 131 Rock Springs, WY 82901
Teton	Rich Ochs	(307) 733-9572	rochs@tetoncountywyo.org	3240 S. Adams Canyon Dr, PO Box 4458 Jackson, WY 83001
Uinta	Kim West	(307) 783-0327	kiwest@uintacounty.com	225 9th Street Evanston, WY 82930
Washakie	Jeff Schweighart	(307) 347-3331	ema.ohs@washakiecounty.net	PO Box 260, 501 15 Mile Road Worland, WY 82401
Weston	Alice Bradshaw	(307) 746-4315	wchls@rtconnect.net	1 W. Main St Newcastle, WY 82701
Eastern Shoshone	Vernon Hill	(307) 335-8367	vernehill@gmail.com	PO Box 538 Fort Washakie, WY 82514
Northern Arapahoe	Harvey Spoonhunter	(307) 332-5318	hshunter@wyoming.com	PO Box 396 Fort Washakie, WY 82514

Information available from: http://wyohomelandsecurity.state.wy.us/counties.aspx

Appendix D. Procedure for jar and stick tests.

Quality Control	Samplers follow the steps described under the *Procedure* section.
Equipment	Clear jar with removable screw top or lid (e.g., Mason jar) Rubber or latex gloves Sturdy stick of sufficient length to reach bloom
Procedure	**Monitoring Objectives:** The following procedures describe simple and inexpensive tests that can be used to assess whether cyanobacteria are present within a bloom. The jar test determines if cyanobacteria are present in the planktonic community by observing the buoyancy of a bloom sample. Cyanobacteria are naturally buoyant and generally aggregate at the surface layer when placed in a jar. It is important to note that a small percentage of cyanobacteria are not buoyant and may not float to the surface layer during a jar test, resulting in a false-negative. Further, certain species of harmless algae are naturally buoyant and may float to the surface layer during a jar test, resulting in a false-positive. Jar tests provide a cursory analysis of cyanobacteria presence, yet the results should not be used as conclusive evidence. Moreover, jar tests do not tell samplers which species of cyanobacteria are present or if cyanotoxins are present in the sample. Results from jar tests should only assist samplers in determining whether further testing is needed. The stick test also determines if cyanobacteria are present by observing how blooms aggregate at the surface layer of a lake or reservoir. Unlike many species of harmless algae, cyanobacteria generally do not form long, filamentous overgrowths that can be largely removed from the water with a stick. The stick test takes advantage of this distinction by determining what type of material is removed from the water when placing and lifting the end of a stick out of a surface scum. It is important to note that cyanobacteria can form small filamentous colonies, however these colonies are not readily removed from water with sticks and form much less extensive networks than algal filaments. As with the jar test, results from a stick test should not be considered definitive, but rather assist samplers during bloom screening events. **Sampling:** Recommend visual inspection of publicly accessible lakes and reservoirs at least weekly during recreation season. In the event of a suspected harmful cyanobacterial bloom (HCB), perform the following tests. Sampling should occur in a location that best characterizes a bloom, represents the area of greatest public threat, and ensures the safety of the samplers. <u>Jar Test</u> 1. Locate a clear jar with a removable screw top or lid. 2. As a precaution, put on rubber or latex gloves prior to sample collection. 3. Remove top from jar and submerge jar in water just below the surface layer.

a. DO NOT collect only surface scums. Collect under the surface scum so sample consists of scum, water and bloom material throughout the upper water column.

4. Ensure that the jar has sufficient volume of water (3/4 full).
5. Remove any scum or bloom material from the outside of the jar.
6. Place and/or screw lid onto the jar.
7. Place jar in refrigerator overnight.
    a. DO NOT disturb the jar during this time.
8. The following day, remove jar from refrigerator and observe.
    a. DO NOT shake or agitate the jar upon removal. Mixing jar contents will not provide useable results.
9. If the bloom material is settled near the bottom of the jar, it is likely that the sample does not contain a significant amount of cyanobacteria.
10. If the bloom material is aggregated at the surface and/or has formed a ring at the top of the jar, it is likely that the sample does contain a significant amount of cyanobacteria.

Stick Test

1. Locate a stick of sufficient length to reach the water surface layer.
    a. DO NOT use a short stick that will result in skin contact to the water.
2. As a precaution, put on rubber or latex gloves prior to sample collection.
3. Place stick into surface scum and lift slowly and as horizontal as possible out of the water.
    a. DO NOT attempt to retrieve material from an unstable location at the water's edge.
4. Observe the end of the stick.
5. If the stick is covered with long strands that appear as green hair or threads, it is likely that the bloom material does not contain a significant amount of cyanobacteria.
6. If the stick is covered with a layer that appears as paint, coagulated clumps, or small grass clippings, it is likely that the bloom material does contain a significant amount of cyanobacteria.

Health and Safety

If skin is directly exposed to cyanobacteria and/or cyanotoxins, immediately rinse with fresh water. Use soap and water to further clean skin. If experiencing additional health effects related to cyanobacteria and/or cyanotoxin exposure, seek medical attention.

References

Kansas Department of Health and Environment. The Jar and Stick Tests. www.kdheks.gov/algae-illness/download/Jar_Test.pdf

Appendix E. Abraxis Quick Reference Guide for cyanotoxin samples

ABRAXIS

Cyanotoxins in Raw Water
Sample Collection Quick Reference Guide

Analyte	Collection/Storage Container	Preservation (at time of sampling)
Anabaenopeptins	Clear or amber glass Polyethylene terephthalate glycol (PETG)	None
Anatoxin-a	Amber glass *Avoid exposure to light, as this will degrade the toxin.*	Immediately upon collection, freshwater samples should be preserved with 10X Concentrated Sample Diluent to prevent adsorptive loss of toxin. *Preservation is necessary for freshwater samples only. Saltwater samples do not require additional reagents for preservation.* *Avoid exposure to high pH conditions, as this will degrade the toxin. Adjust pH to between pH 5 and pH 7.*
BMAA	Clear glass Polyethylene terephthalate glycol (PETG) High density polyethylene (HDPE) Polycarbonate (PC) Polypropylene (PP) Polystyrene (PS) *Avoid amber glass, as toxin will be lost due to adsorption to container surface.*	Freeze *Samples should be analyzed immediately or frozen to avoid degradation of toxin.*
Cylindrospermopsin	Clear or amber glass Polyethylene terephthalate glycol (PETG) High density polyethylene (HDPE) Polycarbonate (PC) Polypropylene (PP) Polystyrene (PS)	None
Microcystins	Clear or amber glass Polyethylene terephthalate glycol (PETG) *Avoid all plastic containers other than PETG, as toxin will be lost due to adsorption to container surface.*	None
Saxitoxin	Clear or amber glass Polyethylene terephthalate glycol (PETG) High density polyethylene (HDPE) Polycarbonate (PC) Polypropylene (PP) Polystyrene (PS)	Immediately upon collection, freshwater samples should be preserved with 10X Concentrated Sample Diluent to prevent adsorptive loss of toxin. *Preservation is necessary for freshwater samples only. Saltwater samples do not require additional reagents for preservation.*

Unless otherwise indicated, samples can be stored refrigerated for up to 5 days. If samples must be held for greater than 5 days, samples should be stored frozen. If samples are to be shipped, they should be shipped overnight, on ice.

R011818

ABRAXIS, Inc. 124 Railroad Drive, Warminster, PA 18974 215-357-3911 Fax: 215-357-5232
info@abraxiskits.com www.abraxiskits.com

APPENDIX F1. Recreational use UNDER INVESTIGATION, ADVISORY, and CLOSURE templates.

UNDER INVESTIGATION

This waterbody is being tested for harmful cyanobacteria. As a precaution:

Do not swim in or come into contact with green water, floating scums or clumps.

Do not ingest water from the bloom. Boiling, filters and other treatments will not make the water safe.

Rinse fish with clean water and eat only the fillet portion.

Avoid water spray from the bloom.

Do not allow pets or livestock to drink water near the bloom, eat bloom material, or lick fur after contact.




Blooms float on or just below the water surface or leave a blue-green paste on the shoreline and can turn the water green or look like threads, clumps, scums and spilled paint.

If you or your pet get sick after water contact or ingestion, call your doctor or veterinarian.

For more information and to check bloom conditions: WyoHCBs.org

Wyoming Department of Health

Wyoming Livestock Board

DEQ Wyoming Department of Environmental Quality

ADVISORY

Harmful cyanobacterial blooms have been identified in this waterbody. To avoid health risks:

Do not swim in or come into contact with green water, floating scums or clumps.

Do not ingest water from the bloom. Boiling, filters and other treatments will not make the water safe.

Rinse fish with clean water and eat only the fillet portion.

Avoid water spray from the bloom.

Do not allow pets or livestock to drink water near the bloom, eat bloom material, or lick fur after contact.




Blooms float on or just below the water surface or leave a blue-green paste on the shoreline and can turn the water green or look like threads, clumps, scums and spilled paint.

If you or your pet get sick after water contact or ingestion, call your doctor or veterinarian.

For more information and to check bloom conditions: WyoHCBs.org

Wyoming Department of Health

Wyoming Livestock Board

DEQ Wyoming Department of Environmental Quality

DANGER

WATERBODY CLOSED

DUE TO HARMFUL CYANOBACTERIA

KEEP OUT OF WATER

Swimming, drinking or any other contact with the water is prohibited. Exposure to harmful cyanobacterial blooms can cause serious illness in humans, pets and livestock.




Blooms float on or just below the water surface or leave a blue-green paste on the shoreline and can turn the water green or look like threads, clumps, scums and spilled paint.

If you or your pet get sick after water contact or ingestion, call your doctor or veterinarian.

For more information and to check bloom conditions: WyoHCBs.org

Wyoming Department of Health

Wyoming Livestock Board

DEQ WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

Appendix F2. Recreational use press release.

Advisory Regarding Harmful Cyanobacterial Blooms (HCBs) in Wyoming Waters

[Insert lake/reservoir name(s)] *Under Advisory*

The Wyoming Department of Health (WDH) is issuing an advisory for [insert lake/reservoir name(s)] due to a harmful cyanobacterial bloom (HCB). HCBs, previously referred to as harmful algal blooms or HABs, are associated with irritants and can produce a number of toxins that may pose a risk to people, pet and livestock health. In the event of an elevated risk or occurrence for toxin production by cyanobacteria, the WDH issues a recreational use health advisory. Under an advisory, WDH recommends the following:

- Avoid contact with the water, especially in areas where cyanobacteria are dense and form scums. Do not use the water for recreational activities that involve frequent contact with the water (i.e., wading, skiing, bathing, and swimming).
- The water should not be consumed. Boiling, filtration and/or chlorination will not remove cyanotoxins and will not make the water safe for drinking.
- Fish can be eaten if they are rinsed with clean water. Eat only the fillet portion of the fish. Discard all fat, skin and organs before cooking as toxins are likely to collect in these tissues.
- Avoid inhalation of water. Do not participate in recreational activities that may cause water to spray or mist. Boating is safe but avoid boating in areas with floating cyanobacteria scums.
- Keep pets and/or livestock away from the water. Do not allow animals to drink the water, eat dried cyanobacteria, or groom themselves after contact with the water.

Contact with cyanobacteria can result in rashes, hives or skin blisters. Human consumption or inhalation of cyanotoxins can cause severe diarrhea, vomiting, nausea, numbness or dizziness. Signs of animal poisoning include weakness, staggering, difficulty breathing, convulsions and death. Cyanobacteria and toxins pose a special health risk for young children, pregnant women, people with compromised immune systems, pets and livestock. If people or animals come into contact with the water, rinse off with clean water as soon as possible. Seek medical attention or call Wyoming Poison Control Center at 1-800-222-1222 if you feel that you have been exposed to cyanotoxins and are experiencing adverse health effects. If pets or livestock are displaying symptoms, call a veterinarian.

Lakes or reservoirs under an Advisory are not closed. Marinas, lakeside parks and camping facilities are open for business. Any closed areas will be specifically noted. Visitors are advised to err on the side of caution, use their best judgement, and follow the recommendations by WDH when using the water.

The Wyoming Department of Environmental Quality (WDEQ), in cooperation with lake and reservoir management agencies, samples publicly accessible lakes and reservoirs in response to HCBs. Additional monitoring is being conducted on [insert lake/reservoir name(s)]. WDH will let you know when the situation has been resolved or if additional precautions should be taken. WDH is working closely with [insert partner(s)] to minimize any potential harm.

For more information, please contact Dr. Karl Musgrave, State Environmental Health Epidemiologist, Wyoming Department of Health, at (307) 777-5825. An emergency hotline is available 24 hours a day at 1(888) 996-9104. Please share this information with all the other people who use the affected water, especially those who may not be aware of the advisory.

APPENDIX G. Laboratories for harmful cyanobacterial bloom analysis.

State	Lab Info	ELISA Method						LC/MS Method						Additional Info
		MC	ATX	CYL	SAX	Time	Other	MC	ATX	CYL	SAX	Time	Other	
AL	Cyanopros 203 Swingle Hall Auburn, AL 36849 (334) 246-1120	$50	-	$100	$100	1-2 days	Turnaround time is based on receipt of frozen samples.	-	-	-	-	-	-	Phytoplankton ID $20
CA (1)	Eurofins Eaton Analytical Monrovia Laboratory 750 Royal Oaks Dr, Ste 100 Monrovia, CA 91016 (626) 386-1100	$100 (MC-LR)	-	-	-	3-10 days	-	$125 (MC-LR)	$350	$350	-	3-10 days	$400 full scan; $300 for 9 MC variants + nodularin	ATX and CYL tests are only available for finished DW or low level detection LC/MS/MS.
FL	GreenWater / CyanoLab 205 Zeagler Dr Ste 302 Palatka, FL 32177 (386) 328-0882	$125	-	$150	$150	1-2 weeks	The lab recommends a PTOX screen ($75) to determine species.	$275	$200	$250	$300	1-2 weeks	The lab recommends a PTOX screen ($75) to determine species.	Discounts are available for bundles or projects.
IA	State Hygienic Lab 2490 Crosspark Rd Coralville, IA 52241 (319) 335-4245	$100	$115	$115	$115	1-2 weeks (rush analyses avail. for extra)	Samples are cheaper when sent in bulk ($75 each for 5-10 samples); sample kits provided	-	Avail.	Avail.	-	1-2 weeks	LC/MS analyses are used for testing drinking water.	Dustin May (dustin-may@uiowa.edu) is the contact.
ID	EcoAnalysts, Inc. 1420 S. Blaine St., Suite 14 Moscow, ID 83843 (208) 882-2588	$125 - $150	$125 - $150	$125 - $150	$125 - $150	5 days	Analyses are cheaper when ran in batches; 48 hour expedited services cost 25% extra	-	-	-	-	-	-	Cyanobacteria ID and enumeration is $150 (5 days but can be expedited).
IN (2)	Eurofins Eaton Analytical South Bend Laboratory 110 South Hill Street South Bend, IN 46617 (574) 233-4777	$100 (MC-LR)	-	-	-	3-10 days	-	$125 (MC-LR)	$350	$350	-	3-10 days	$400 full scan; $300 for 9 MC variants + nodularin	ATX and CYL tests are only available for finished DW or low level detection LC/MS/MS.
MI	LSSU Enviro Analysis Lab 650 W Easterday Ave Sault Ste. Marine, MI 49783 (906) 635-2076	$110	$110	$110	$110	1-2 days	Prices are based on 1 MC sample; prices are negotiable.	$150	$150	$150	$150	5 days	Prices are negotiable; MC analysis does 10-12 variants.	Ben Southwell (bsouthwell@lssu.edu) willing to work with agencies.
NE	Midwest Laboratories, Inc 13611 B Street Omaha, NE 68144 (402) 334-7770	$40	-	-	-	3-5 days	-	-	-	-	-	-	-	Contact Rob Ferris (rob@midwestlabs.com)
MT	Rhithron Assoc. Incorporated 33 Ft Missoula Rd MT 59804 (406) 721-1977	-	-	-	-	-	-	-	-	-	-	-	-	Cyanobacteria identification and enumeration $200

State	Lab Info	ELISA Method						LC/MS Method						Additional Info
		MC	ATX	CYL	SAX	Time	Other	MC	ATX	CYL	SAX	Time	Other	
OH	BSA Environmental Services 23400 Mercantile Rd, Ste 8 Beachwood, OH 44122 (216) 765-0582	$90	-	-	-	1-2 days	The lab recommends sending samples by Wed./Thurs.	Yes	Yes	Yes	Yes	3 days	$400 suite anlaysis	Jon Beaver (j.beaver@bsaenv.com)
OH	EnviroScience 5070 Stow Rd Stow, OH 44224 (330) 688-0111	$130	$150	$130	$130	2 days	-	qPCR: $120	-	qPCR: $120	qPCR: $120	2 days	-	-
OK	Oklahoma DEQ 707 N. Robinson Oklahoma City, OK 73102 (405) 702-1000	$173	-	$147	$105	2 days	-	-	-	-	-	-	-	$163 for ID and enum.; current estimates are 2016 prices; prices available on website.
OR	Bend Genetics, LLC 226 Nash Hall Corvallis, OR 97331 (541) 600-4363	$100 - $125	$100 - $125	$100 - $125	$100 - $125	1-3 days	Discounts are available for bulk samples.	qPCR: $125 - $150	qPCR: $125 - $150	qPCR: $125 - $150	qPCR: $125 - $150	1-3 days	The lab recommends pairing ELISA with qPCR to confirm results.	Mention of $425 suite analysis.
WA	Advanced Eco-Solutions 25011 E Trent Ave Ste A PO Box 201 Newman Lake, WA 99025 (208) 660-8733	$120	$130	$130	-	≥ 1 day	Analyses are run on Fridays; analyses will be run on Wednesdays if there are more samples.	-	-	-	-	-	-	Per sample costs include sample bottles, preservatives, collect/ship methodologies. ID and enum. $125
WI	State Lab of Hygiene 2601 Agriculture Dr. Madison, WI 53718 (608) 224-6230	$85	$85	$85	$85	Rush: 2-3 days	Lab will prioritize analysis if it is an emergency; standard analyses take 2 weeks.	HPLC method	-	-	HPLC method	-	The HPLC method can do batch toxin analysis.	Dawn Perkins (dawn.perkins@slh.wisc.edu) would need to be notified of emergencies.

Cyanotoxin abbreviations: MC, microcystin; ATX, anatoxin; CYL, cylindrospermopsin; SAX, saxitoxin.
Cells marked with "-" indicate that tests or information are unavailable.
Cost estimates are based on information received in May 2017.

APPENDIX H. Harmful cyanobacterial bloom flyer.

HARMFUL CYANOBACTERIAL BLOOMS

What are Harmful Cyanobacterial Blooms or HCBs?

- HCBs are dense accumulations of cyanobacteria or "blue-green algae"
- HCBs are "harmful" because they can produce toxins and other irritants
- Toxins and irritants can cause rashes and illnesses in humans and animals

What do you need to look for?

- HCBs usually turn the water a blue-green color
- HCBs can look like spilled-paint, grass clippings, or blue-green scum and leave a blue-green paste on the shoreline
- HCBs can occur on or just below the water surface

What to do if you see a HCB?

- Avoid blooms when recreating in the water
- If you or your pet feel sick or get a rash after coming into contact with a bloom, rinse off with clean water and call your doctor or veterinarian

Report blooms to DEQ's *Report a Spill* hotline at WyoSpills.org or 307-777-7501

Health information at http://www.cdc.gov/habs/

For more information and to check bloom conditions: WyoHCBs.org

Wyoming Department of Health

Wyoming Livestock Board

DEQ Wyoming Department of Environmental Quality

APPENDIX I. References.

Carmichael, WW, 1992. A Review: Cyanobacteria Secondary Metabolites – the Cyanotoxins. Journal of Applied Bacteriology 72:445-459.

Farrer, D, M Counter, R Hillwig, and C Cude, 2015. Health-Based Cyanotoxin Guideline Values Allow for Cyanotoxin-Based Monitoring and Efficient Public Health Response to Cyanobacterial Blooms. Toxins 7:457-477.

Fawell, JK, J Hart, HA James, and W Parr, 1993. Blue-green Algae and Their Toxins – Analysis, Toxicity, Treatment and Environmental Control. Water Supply 11:109-121.

Graham, JL, KA Loftin, and N Kamman, 2009. Algal Toxins: Monitoring Recreational Freshwaters. Lakeline, Summer 2009, 18-24.

Ohio EPA, 2014. Public Water System Harmful Algal Response Strategy (Draft). Ohio Environmental Protection Agency, Columbus, Ohio. Available online: http://epa.ohio.gov/ddagw/HAB.aspx

Otten, TG, and HW Paerl, 2015. Health Effects of Toxic Cyanobacteria in US Drinking and Recreational Waters: Our Current Understanding and Proposed Direction. Current Environmental Health Reports 2:75-84.

US Environmental Protection Agency (USEPA). Policies and Guidelines. Available online: http://www2.epa.gov/nutrient-policy-data/policies-and-guidelines

USEPA, 2015a. Drinking Water Health Advisory for the Cyanobacterial Toxin Cylindrospermopsin. US Environmental Protection Agency, Office of Water, Health and Ecological Criteria Division, Washington, DC. Available online: https://www.epa.gov/nutrient-policy-data/drinking-water-health-advisory-documents

USEPA, 2015b. Drinking Water Health Advisory for the Cyanobacterial Microcystin Toxins. US Environmental Protection Agency, Office of Water, Health and Ecological Criteria Division, Washington, DC. Available online: https://www.epa.gov/nutrient-policy-data/drinking-water-health-advisory-documents

USEPA, 2016. Draft Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin. US Environmental Protection Agency, Office of Water, Health and Ecological Criteria Division, Washington, DC. Available online: https://www.epa.gov/wqc/draft-human-health-recreational-ambient-water-quality-criteria-andor-swimming-advisories

USEPA, 2019. Recommended Human Health Recreational Ambient Water Quality Criteria or Swimming Advisories for Microcystins and Cylindrospermopsin. US Environmental Protection Agency, Office of Water, Health and Ecological Criteria Division, Washington, DC. Available online: https://www.epa.gov/sites/production/files/2019-05/documents/hh-rec-criteria-habs-document-2019.pdf

USGS, 2008. Cyanobacteria in Lakes and Reservoirs: Toxin and Taste-and-Odor Sampling Guidelines. Cyanobacteria, Version 1.0, Chapter A7, Biological Indicators. United States Geological Survey.

WDEQ/WQD, 2013. Water Quality Rules and Regulations. Chapter 1, Wyoming Surface Water Quality Standards. Wyoming Department of Environmental Quality, Water Quality Division, Cheyenne, Wyoming. Available online: http://deq.state.wy.us/wqd/WQDrules/Chapter_01.pdf

WHO, 1999. Toxic Cyanobacteria in Water: A Guide to Their Public Health Consequences, Monitoring, and Management. World Health Organization, London, UK.